

Climate resilient farming:

India initiatives

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Climate change is a major area of concern for Indian agriculture in view of its high vulnerability and dominance of small holder farms. Agriculture sector is exposed to extreme events like droughts, floods, heat wave, cold wave, unseasonal rains, cyclones etc. causing immense loss year after year. Indian agri R&D system has evolved a number of crop and livestock management practices to cope with abiotic stresses induced by climate variability, but climate change impacts continue to remain a major challenge to both policy makers and farmers. Government of India through ICAR, initiated a large network project called National Innovation on Climate Resilient Agriculture (NICRA) a decade ago involving major R&D institutes of ICAR dealing with natural resource management, crops, horticulture, livestock and fisheries. The project aims at not only developing climate resilient technologies but also demonstrate them on farmers' fields in most vulnerable districts across the country. The project also has a strong component on farmer's capacity building through Krishi Vignan Kendras (KVKs). The project has resulted in developing and refining a number of technologies like climate resilient crop cultivars, soil carbon improvement and carbon sequestration through agroforestry, water saving agronomic practices, and improved feeding protocols for livestock and poultry to minimize heat stress impacts.

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CLIMATE change is a global phenomenon. As per the 6th Assessment Report by IPCC (AR-6), Climate change concerns are increasing at faster pace than expected, making the global food production at risk. South Asian countries, including India, is highly vulnerable to changing climates, as majority of the population depend on agriculture. In India, more than half the cultivated area is rain dependent and 86% of farmers are small and marginal, with land holding less than 2 ha. Agriculture is the only sector that has contributed to positive growth in the COVID-19 pandemic with a growth of 3.4% that resulted in an increase in its share in gross domestic product (GDP) to 19.9% in 2020–21 from 17.8% in 2019–20 with about 50% of workforce engaged in this sector. Over the past two decades the country is experiencing frequent extreme weather events like drought, flood, cyclones, heat wave, cold wave, making Indian agriculture highly risk prone. Agricultural sector is likely to be one of the worst affected directly in terms of crop yields, water availability and indirectly through changes in pest and pathogen incidence. Studies showed that the

consequences future climate changes could be more severe affecting the livelihood security of farmers in the country.

National Mission on Sustainable Agriculture (NMSA)

The Prime Ministers' National Action Plan on Climate Change (NAPCC) was initiated in 2008. It outlines a national strategy that aims to enable the country to adapt to climate change and enhance the ecological sustainability of India's development path. It stresses that maintaining a high growth rate is essential for increasing living standards of the vast majority of people of India and reducing their vulnerability to the impacts of climate change. NAPCC has identified agriculture as one of the key sectors. Out of 8 National Missions in India, National Mission on Sustainable Agriculture (NMSA) is related to agricultural sector. NMSA has been made operational from the year 2014. It aims at making agriculture more productive, sustainable, remunerative and climate resilient by promoting location specific integrated farming systems, soil and moisture conservation measures,

comprehensive soil health management, efficient water management practices and mainstreaming rain-fed technologies, enhancing water use efficiency through promoting technological interventions like drip and sprinkler technologies, efficient water application and distribution system, secondary storage etc. These activities have been subsumed under the 'Per Drop More Crop (PDMC)' component of Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) during 2015–16. Soil Health Management (SHM) is one of the components under NMSA, aims at promoting Integrated Nutrient Management (INM) through judicious use of chemical fertilizers including secondary and micro nutrients in conjunction with organic manures and bio-fertilizers for improving soil health and its productivity, strengthening of soil and fertilizer testing facilities to improve soil test-based recommendations to farmers for improving soil fertility. Soil Health Card Scheme has been under implementation in the country since February, 2015 to provide Soil Health Cards to all farmers in the country. Soil Health Card will provide information to farmers on nutrients status of their soil and recommendation on appropriate dosage of nutrients to be applied for improving soil health and its fertility.

National Innovation on Climate Resilient Agriculture (NICRA)

Climate change challenges in agriculture and allied sectors addressed by Indian Council of Agricultural Research through 'National Innovations on Climate Resilient Agriculture' (NICRA) Project. This flagship project is dedicated to enhance the resilience of Indian agriculture through development and application of improved production and risk management technologies. The NICRA project was launched in 2011, amidst growing consensus that climate was changing and the world will experience a much warmer climate owing to greenhouse gases that have accumulated in the atmosphere over the years. The schemes aim to develop and promote climate resilient technologies that help the districts and regions prone to extreme weather



Greenhouse facilities established under NICRA

conditions like droughts, floods, frost, heat waves, etc. to cope with such extremes.

State-of-the-art infrastructure facilities have been established under NICRA across the country to facilitate the climate change research on crops, livestock, fisheries, natural resources like soil organic carbon and water. More than 1,600 scientists, research scholars and students from different parts of the country are engaged in climate change research. Studies of climate change impacts on agriculture indicated that in the absence of adoption of adaptation measures, climate change projections are likely to reduce irrigated rice yields by 12%, wheat yield by 9% and rainy (*kharif*) season maize by 18% by 2050.

Risk assessment of Indian agriculture to climate change

A study on risk and vulnerability assessment of agriculture to climate change showed that out of 573 districts, 109 were very high risk prone and 201 were highly prone. This document is useful to the policy makers and research managers for prioritization of resources related to climate change action plans. By providing information on districts that have relatively high risk and more vulnerable to climate change this study can be handy in planning for adaptation, vulnerability and risk reduction. Further, ICAR collaborated with state governments and prepared Contingency Plans for 650 districts and provided technological solutions for major weather aberrations. Based on the advanced seasonal forecast before the commencement of annual rainy (*kharif*) season, contingency plan interface meetings were organized in the presence of senior district officials to ensure necessary policy interventions.

Resilient crop management practices

Screening of numerous germplasm including local genetic resources in several crops for different abiotic stresses (drought, heat, salinity, NUE, submergence tolerance etc.) helps in identifying donors for stress tolerance. Genes responsible for imparting resistance for climatic stresses in field crops have been identified and characterized through molecular approaches. Thousands of wild germplasm lines collected from several locations across the country have been screened to identify new sources which could be used in future breeding programs to develop new tolerant varieties to drought, flood and heat stress. To improve the food grain production, resilient varieties to climatic stresses have been developed and released for cultivation in different crops. Prominent drought tolerant varieties and resilient cropping systems adopted by farmers resulted in yield advantage to a greater extent. Resilient inter-cropping systems in place of sole crops, contributed in stabilizing productivity under variable climatic stresses in frequently drought affected regions in peninsular and central India. These climate resilient varieties have been introduced in drought, flood, heat wave affected districts, well adopted by farmers resulting in increased crop yields and monetary returns at different locations. On-farm evaluation of several climate resilient varieties

in different crops were demonstrated and integrated into developmental programs in climatically vulnerable districts.

Managing natural resources

The distribution and intensity of rainfall is increasing causing severe yield loss. Therefore, it is important to catch the rain water where it falls through water harvesting structures. Location-specific technologies for rainwater harvesting with farm ponds, percolation tanks, check dams etc. have been developed. Groundwater recharge technologies including open well and tube well recharge models have been developed and upscaled. Harvested water was used for increasing the cropping intensity by bringing more area under cultivation, resulting in enhanced yields and returns.

The *in situ* and *ex situ* water harvesting structures enabled efficient use of harvested water resulted in higher yields and net returns under deficit rainfall conditions. Apart from water, soil health management is also prime importance for sustainable agriculture. Soil health management aims to promote crop and location specific sustainable practices that includes residue management, organic farming practices, nutrient management, balanced application of fertilizers, minimizing the soil erosion and degradation. Soil aggregates and water stability improved under conservation treatments. Balanced fertilization and integrated nutrient management systems are the keys to sustainable crop production in terms of building up of soil carbon, structural stability and crop yield.

Climate resilient villages

Large scale demonstration of location specific resilient technologies was undertaken in 151 clusters, covering 446 villages to address major climatic vulnerabilities. Under NICRA project water harvesting structures have been made and efficient use of harvested water resulted in higher yields and net returns under deficit rainfall conditions in major crops. The extent of yield



Water harvesting structure in NICRA village

improvement due to critical irrigation is up to 85% in some of the low rainfall regions. Harvested water was used for increasing the cropping intensity by bringing more area under winter (*rabi*) crops resulting in enhanced yields and returns in crops such as wheat, mustard, chickpea and vegetable crops. Demonstration of zero tillage cultivation is being taken up contributing residue burning free villages. Livestock is an integral part of farming in India. In the NICRA villages, farmers are introduced to several innovative resilient technologies to breed improvement, shelter and feed management that protect livestock from climate-induced thermal stress and climate induced animal diseases. Enhancing preparedness of fishing communities has been undertaken in few fishing villages by establishing basic community infrastructure, strengthening seawalls and bio shields. To improve income of fisher communities, a multi-vendor e-commerce system has been developed using the information and communication techniques.

Innovative institutional interventions, viz. village climate risk management committee, custom hiring centres, seed and fodder production systems set up in NICRA villages enabled farmers to take up timely farm operations, access to quality seed and fodder, and generate significant revenues. During the past decade, 17,000 capacity building programs were conducted throughout the country under NICRA project to educate stakeholders on various aspects of climate change and resilient technologies, covering 5 Lakhs stakeholders so as to enable wider adoption of climate resilient technologies. The technologies developed through active participation of farmers and other stakeholders in these 151 pilot sites are ready to be integrated with developmental programmes of different Ministries, so that they can reach to a large number of farmers and secure their livelihood. Convergence with the development departments is the key to upscale the proven resilient technologies in the district. These technologies are being upscaled by convergence with the relevant state and central departments, viz. RKVY, IWMP, ATMA, ITDA, MGNREGA, NABARD, PMAY-G, NHM, NFSM, IWMP, APART, AAU-Jorhat, ITDP,



Rainwater harvesting with farm ponds

PMKSY and other line departments. Demonstrating such resilient technologies in the farmers' fields across the country will make the benefits to large number of farmers in the vulnerable districts.

Crop diversification

Crop diversification is intended to give a wider choice in the production of a variety of crops in each area to expand production related activities on various crops and also to lessen risk. In India it is generally viewed as a shift from traditionally grown less remunerative crops to more remunerative crops. Often low volume high-value crops like spices and several horticultural crops also aid in crop diversification. Higher profitability, resilience and stability in production also induce crop diversification. Crop diversification is a practice in rainfed lands to reduce the risk factor of crop failures due to drought. State-wise efficient cropping systems have been identified in terms of productivity and profitability for crop diversification and efforts are under way for its wide scale implementation. Further, these efficient and diversified cropping systems are integrated while developing either prototype IFS models or refining the IFS models already existing and being adopted by the farmers through farmer participatory research at 37 locations. In farming system mode, there is a great scope for further diversification due to inclusion of horticulture and agroforestry component. Maximum agrobiodiversity can be achieved through optimal combination of components involving tree-crop-livestock. These principles are adopted while developing the identified 64 IFS models. Because of higher Sustainability Yield Index (SYI) and Sustainable Value Index (SVI) of these IFS models they are included in action plans of some states like Kerala, Tamil Nadu and Odisha.

G20 Meeting of Agricultural Chief Scientists (MACS)

Under the G20 Presidency of India, the Meeting of Agricultural Chief Scientists (MACS) was held during 17-19 April, 2023 at Varanasi, India. The G20 Member States, Invited Countries and several International Organizations participated in the MACS to discuss

and identify the Research and Development (R&D) priorities in agriculture to foster transformation towards diverse, resilient and sustainable agriculture, and food systems. The conference recognized global food security concerns aggregated by climate change and the need for enhancing R&D collaborations between the public and private sector to build resilient agriculture and food systems, find solutions for climate change adaptation, and mitigation without adverse effects on food security, protect and enhance bio-diversity, and help improve productivity and profitability sustainably in global agri-food value chains. Effective investments in agricultural research and innovations will enhance the capacity to build resilience to climate change. Success of public and private sector collaboration in R&D depends on scaling up of innovations and information sharing.

SUMMARY

The climate resilient agriculture initiative in India is very encouraging and lead by example for many other developing countries. NICRA interventions were found to increase resilience at farm, household and village level, and has been successful in changing the lives of millions of farmers in our country. The climate resilient technologies developed and evaluated under NICRA are being upscaled by several state governments across the country. Taking NICRA villages as model, various state governments have initiated programmes like PoCRA in Maharashtra and climate smart agriculture in Bihar with an aim to make agriculture resilient to changing climate. Up-scaling the resilient practices by involving development departments, corporates, by developing entrepreneurship at the village so as to reach millions of the small holders. Though the major emphasis in agriculture sector in India is towards adaptation and co-benefits of adaptation, efforts are also made towards mitigation through several schemes being implemented on a large scale. Integrated approach at village level by implementing the package of climate resilient practices over years will pave the way towards climate resilient farming.

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Water

Even though households are relatively low consumers of water, population growth and expanded water use have outweighed the effect of water saving technology and behavior.

- Less than 3% of the world's water is fresh (drinkable), of which 2.5% is frozen in the Antarctica, Arctic and glaciers. Humanity must therefore rely on 0.5% for all of man's ecosystem's and fresh water needs.
- Man is polluting water faster than nature can recycle and purify water in rivers and lakes. More than one billion people still do not have access to fresh water.
- Excessive use of water contributes to the global water stress. Water is free from nature but the infrastructure needed to deliver it is expensive.

- See more at: <http://www.unep.org/wed/theme/water.asp#sthash.ki5vg3lB.dpuf>
Courtesy: United Nations Environment Programme website - <http://www.unep.org/wed>